

*CONFIDENTIAL*

PALM-3675.US.P

UNITED STATES PATENT APPLICATION FOR

IMPLEMENTATION OF ELECTRONIC MUSCLES IN A PORTABLE COMPUTER  
AS USER INPUT/OUTPUT DEVICES

Inventors:

Shawn Gettemy  
Yoon Kean Wong

Prepared by:

WAGNER, MURABITO & HAO LLP  
Two North Market Street  
Third Floor  
San Jose, California 95113  
(408) 938-9060

PALM-3675/ACM/CWS

IMPLEMENTATION OF ELECTRONIC MUSCLES IN A PORTABLE COMPUTER  
AS USER INPUT/OUTPUT DEVICES

BACKGROUND OF THE INVENTION

5 FIELD OF THE INVENTION

The present invention relates to the field of portable computer systems, such as personal digital assistants or palmtop computer systems. Specifically, embodiments of the present invention relate to a portable computer system equipped with a dielectric elastomer actuator (e.g., an electronic muscle material) for navigating, vibrating, generating audio output and sensing a plurality of actions for which accommodations can be provided.

10 RELATED ART

A portable computer system, such as a personal digital assistant (PDA) or palmtop, is an electronic device that is small enough to be held in the hand of a user and is thus "palm-sized." By virtue of their size, portable computer systems are lightweight and so are exceptionally portable and convenient. These portable computer systems are generally contained in a housing constructed of conventional materials such as rigid plastics or metals.

15

Portable computer systems are generally powered using either rechargeable or disposable batteries. Because of the desire to reduce the size and weight of the portable computer system to the extent practical, smaller batteries are used. Thus, power conservation in portable computer systems is an important consideration in order to reduce the frequency at which the batteries either need to be recharged or replaced. Consequently, the portable

computer system is placed into a low power mode (e.g., a sleep mode or deep sleep mode) when it is not actively performing a particular function or operation.

There are many other similar types of intelligent devices (having a

- 5 processor and a memory, for example) that are sized in the range of laptops and palmtops, but have different capabilities and applications. Video game systems, cell phones, pagers and other such devices are examples of other types of portable or hand-held systems and devices in common use.

These systems, and others like them, have in common some type of screen for displaying images as part of a user interface. Many different kinds of screens can be used, such as liquid crystal displays, and field emission displays or other types of flat screen displays.

15 These systems also have in common some type of user interface allowing a user to input commands and information and to navigate either within an application or from one application to another. In the case of laptops and some of the other hand-held devices, an optional alphanumeric input device including alphanumeric and function keys (e.g., a keyboard) can be provided. The keyboard can also be used to control a cursor on the display device, or an optional cursor control device (e.g., a mouse, trackball, joystick, stylus, or touchpad) can be used. It is well known how a cursor can be used to select various functions, commands and applications, and how a cursor can be used to navigate within applications.

In the case of palmtops and other such devices, the display device is typically covered by a touch sensor (touchpad) which is able to register contact between the screen and the tip of a stylus element. The user can input commands and move between applications by touching the stylus to various parts of the screen or to virtual buttons rendered on the screen. Many palmtops are also equipped with a handwriting recognition pad (e.g., a graffiti area, digitizer or digitizer tablet) that can recognize characters traced on the pad by a user. Palmtops and many other hand-held devices also have built-in dedicated or programmable buttons or keys that can be used to implement various functions and to navigate among and within different applications (see Figure 1).

Some portable computers contain speakers for audible alarms or for playing recorded messages. Likewise, they may contain microphones for recording information. Some also contain mechanisms that cause the device to vibrate when the audible alarm is turned off.

Thus, there are various well-known mechanisms that are used in the prior art to provide a user interface for hand-held and/or portable computer systems and the like, including laptops and palmtops. These mechanisms tend to work well with the different types of display devices and other mechanisms currently in use.

However, the paradigm of applying conventional user interface mechanisms to hand-held, portable devices does not take full advantage of the

user's capability to control and manipulate such devices. The built-in dedicated buttons are not always located in a convenient place on the housing and are subject to mechanical failure, as are the speakers and microphones. Thus, it is desirable to provide a user-friendly interface that more fully utilizes the 5 advantages afforded by the portability of hand-held devices. An improved interface can facilitate the user's experience and thus provide an advantage over other devices that employ conventional user interfaces.

A material called a dielectric elastomer has recently been introduced by  
10 Ron Pelrine, et. al. of SRI International. Information on this material is published  
in Proceedings of SPIE Vol. 4329 (Electroactive Polymer Actuators and  
Devices, 2001) from Smart Structures and Materials Symposium 2001, March  
4-8, Newport Beach, California. This information is hereby incorporated by  
reference as background material.  
15

## SUMMARY OF THE INVENTION

Accordingly, what is needed is a system and/or method that can provide a user interface to perform many functions of the portable computer systems and other like devices using a technology such as a dielectric elastomer

- 5 material as part of the user interface with the device. What is also needed is a system and/or method that can accomplish the above and that can also be used to enhance other functions or generate new functions of the device using existing material technologies. Furthermore, what is needed is a system and/or method that can accomplish the above and that can provide these functions for 10 smaller hand-held devices. The present invention provides these advantages and others not specifically mentioned above but described in the sections to follow.

The preferred embodiment of the present invention pertains to a system and/or method that can provide a user interface to perform many functions of the computer systems and other like devices using a dielectric elastomer, hereafter referred to as "electronic muscle", material as part of the user interface with the device. Other functions of the device can be enhanced or new functions generated using existing material technologies. Furthermore, the present 20 invention can achieve all the above and can provide these functions for smaller (e.g., hand-held) devices.

A portable computer system contained within a housing, which comprises an electronic muscle material for performing a plurality of functions, 25 is disclosed. The electronic muscle material can be used as external buttons or

keys to invoke PDA functions. In one embodiment the movement of the electronic muscle material can charge the battery. When handled, the electronic muscle material can further detect the left- or right-handedness of the user and,

based on the handedness, can automatically generate function buttons, the

- 5 placement of which may accommodate the user's hand preference and finger placement. The electronic muscle can change shape to accommodate the user's hand for comfort and, further, as a security function to identify and authorize the user. Additionally, the electronic muscle material in the housing can be caused to vibrate at given frequencies so that it can generate an alarm and can function as a speaker or a dynamically directional microphone.
- 10

The portable computer system that is described has a housing comprising an electronic muscle material which, when moved, causes the housing to behave in a prescribed manner. The housing contains a bus and

15 there is a battery within the housing coupled to the bus. There is a processor coupled to the bus along with a display device for providing a visual display and a user interface for controlling the display.

In one embodiment, the movement of the electronic muscle material in

- 20 the housing of the portable computer system can be used to charge the battery.

In another embodiment, the movement of the electronic muscle material can

also sense the handling by a user and can determine if the user is right-handed or left-handed. Once the location of the user's fingers, and thus the user's handedness, is sensed, function buttons for scrolling and/or selecting menu

- 25 items can be generated in the proximity of the user's fingers from the electronic muscle material. Additionally, graphical user interface tools, e.g., a scroll bar,

can be displayed along the side of the display module that best suits the user's handedness.

In one embodiment, the function buttons generated from the electronic muscle material can be caused to vibrate as an alarm to apprise the user of a relevant message being displayed. Similarly, the function buttons can be caused to protrude from the housing to apprise the user of a relevant message being displayed. Also, the entire electronic muscle material can be caused to vibrate as an alarm for apprising the user of a message being displayed.

In yet another embodiment, the electronic muscle material of the portable computer system can conform to the shape of user's hand for improved ergonomics. This conformance to the shape of the user's hand can identify the user for authorization purposes.

In another embodiment of this portable computer system, the electronic muscle material can be caused to vibrate at the frequency of external sound for use as a microphone. The electronic muscle material can, similarly, be caused to vibrate at the frequency of an analog or digital signal for use as a speaker.

Another feature of this vibration is that the location of the vibration can move spatially about the housing for tracking the strongest signal.

Other features and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention:

5

Figure 1 illustrates a prior art electronic device with built-in dedicated buttons for scrolling or for selecting among menu items.

10 Figure 2 is a topside perspective view of a portable computer system in accordance with one embodiment of the present invention.

15 Figure 3 is a bottom side perspective view of the portable computer system of Figure 2.

Figure 4 is a block diagram of an exemplary portable computer system upon which embodiments of the present invention may be practiced.

20 Figure 5 is a block diagram illustrating the generation of customized features based on the user's left- or right-handedness.

Figure 6 illustrates the electronic muscle material sensing the contour of finger placement according to one embodiment of the present invention.

25 Figure 7 illustrates an exemplary configuration for function button placement.

Figure 8 is a figure illustrating the generation of function buttons in three embodiments of the present invention.

5       Figure 9 is a block diagram illustrating the process followed for generating alarms in one embodiment of the present invention.

10      Figure 10 illustrates the conformance of the housing to the contour of the user's hand in one embodiment of the present invention

15      Figure 11 is a block diagram illustrating the validation of the user utilizing the contour of the user's hand.

20      Figure 12 illustrates one embodiment of the present invention in which the electronic muscle material functions as a speaker.

25      Figure 13 illustrates one embodiment of the present invention in which the electronic material functions as a dynamically directional microphone.

## DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be recognized by one skilled in the art that 5 the present invention may be practiced without these specific details or with equivalents thereof. In other instances, well-known methods, procedures, components, and circuits have not been described in detail as not to unnecessarily obscure aspects of the present invention.

10  
15  
20  
25  
30  
35  
40  
45  
50  
55  
60  
65  
70  
75  
80  
85  
90  
95  
100  
105  
110  
115  
120  
125  
130  
135  
140  
145  
150  
155  
160  
165  
170  
175  
180  
185  
190  
195  
200  
205  
210  
215  
220  
225  
230  
235  
240  
245  
250  
255  
260  
265  
270  
275  
280  
285  
290  
295  
300  
305  
310  
315  
320  
325  
330  
335  
340  
345  
350  
355  
360  
365  
370  
375  
380  
385  
390  
395  
400  
405  
410  
415  
420  
425  
430  
435  
440  
445  
450  
455  
460  
465  
470  
475  
480  
485  
490  
495  
500  
505  
510  
515  
520  
525  
530  
535  
540  
545  
550  
555  
560  
565  
570  
575  
580  
585  
590  
595  
600  
605  
610  
615  
620  
625  
630  
635  
640  
645  
650  
655  
660  
665  
670  
675  
680  
685  
690  
695  
700  
705  
710  
715  
720  
725  
730  
735  
740  
745  
750  
755  
760  
765  
770  
775  
780  
785  
790  
795  
800  
805  
810  
815  
820  
825  
830  
835  
840  
845  
850  
855  
860  
865  
870  
875  
880  
885  
890  
895  
900  
905  
910  
915  
920  
925  
930  
935  
940  
945  
950  
955  
960  
965  
970  
975  
980  
985  
990  
995  
1000  
1005  
1010  
1015  
1020  
1025  
1030  
1035  
1040  
1045  
1050  
1055  
1060  
1065  
1070  
1075  
1080  
1085  
1090  
1095  
1100  
1105  
1110  
1115  
1120  
1125  
1130  
1135  
1140  
1145  
1150  
1155  
1160  
1165  
1170  
1175  
1180  
1185  
1190  
1195  
1200  
1205  
1210  
1215  
1220  
1225  
1230  
1235  
1240  
1245  
1250  
1255  
1260  
1265  
1270  
1275  
1280  
1285  
1290  
1295  
1300  
1305  
1310  
1315  
1320  
1325  
1330  
1335  
1340  
1345  
1350  
1355  
1360  
1365  
1370  
1375  
1380  
1385  
1390  
1395  
1400  
1405  
1410  
1415  
1420  
1425  
1430  
1435  
1440  
1445  
1450  
1455  
1460  
1465  
1470  
1475  
1480  
1485  
1490  
1495  
1500  
1505  
1510  
1515  
1520  
1525  
1530  
1535  
1540  
1545  
1550  
1555  
1560  
1565  
1570  
1575  
1580  
1585  
1590  
1595  
1600  
1605  
1610  
1615  
1620  
1625  
1630  
1635  
1640  
1645  
1650  
1655  
1660  
1665  
1670  
1675  
1680  
1685  
1690  
1695  
1700  
1705  
1710  
1715  
1720  
1725  
1730  
1735  
1740  
1745  
1750  
1755  
1760  
1765  
1770  
1775  
1780  
1785  
1790  
1795  
1800  
1805  
1810  
1815  
1820  
1825  
1830  
1835  
1840  
1845  
1850  
1855  
1860  
1865  
1870  
1875  
1880  
1885  
1890  
1895  
1900  
1905  
1910  
1915  
1920  
1925  
1930  
1935  
1940  
1945  
1950  
1955  
1960  
1965  
1970  
1975  
1980  
1985  
1990  
1995  
2000  
2005  
2010  
2015  
2020  
2025  
2030  
2035  
2040  
2045  
2050  
2055  
2060  
2065  
2070  
2075  
2080  
2085  
2090  
2095  
2100  
2105  
2110  
2115  
2120  
2125  
2130  
2135  
2140  
2145  
2150  
2155  
2160  
2165  
2170  
2175  
2180  
2185  
2190  
2195  
2200  
2205  
2210  
2215  
2220  
2225  
2230  
2235  
2240  
2245  
2250  
2255  
2260  
2265  
2270  
2275  
2280  
2285  
2290  
2295  
2300  
2305  
2310  
2315  
2320  
2325  
2330  
2335  
2340  
2345  
2350  
2355  
2360  
2365  
2370  
2375  
2380  
2385  
2390  
2395  
2400  
2405  
2410  
2415  
2420  
2425  
2430  
2435  
2440  
2445  
2450  
2455  
2460  
2465  
2470  
2475  
2480  
2485  
2490  
2495  
2500  
2505  
2510  
2515  
2520  
2525  
2530  
2535  
2540  
2545  
2550  
2555  
2560  
2565  
2570  
2575  
2580  
2585  
2590  
2595  
2600  
2605  
2610  
2615  
2620  
2625  
2630  
2635  
2640  
2645  
2650  
2655  
2660  
2665  
2670  
2675  
2680  
2685  
2690  
2695  
2700  
2705  
2710  
2715  
2720  
2725  
2730  
2735  
2740  
2745  
2750  
2755  
2760  
2765  
2770  
2775  
2780  
2785  
2790  
2795  
2800  
2805  
2810  
2815  
2820  
2825  
2830  
2835  
2840  
2845  
2850  
2855  
2860  
2865  
2870  
2875  
2880  
2885  
2890  
2895  
2900  
2905  
2910  
2915  
2920  
2925  
2930  
2935  
2940  
2945  
2950  
2955  
2960  
2965  
2970  
2975  
2980  
2985  
2990  
2995  
3000  
3005  
3010  
3015  
3020  
3025  
3030  
3035  
3040  
3045  
3050  
3055  
3060  
3065  
3070  
3075  
3080  
3085  
3090  
3095  
3100  
3105  
3110  
3115  
3120  
3125  
3130  
3135  
3140  
3145  
3150  
3155  
3160  
3165  
3170  
3175  
3180  
3185  
3190  
3195  
3200  
3205  
3210  
3215  
3220  
3225  
3230  
3235  
3240  
3245  
3250  
3255  
3260  
3265  
3270  
3275  
3280  
3285  
3290  
3295  
3300  
3305  
3310  
3315  
3320  
3325  
3330  
3335  
3340  
3345  
3350  
3355  
3360  
3365  
3370  
3375  
3380  
3385  
3390  
3395  
3400  
3405  
3410  
3415  
3420  
3425  
3430  
3435  
3440  
3445  
3450  
3455  
3460  
3465  
3470  
3475  
3480  
3485  
3490  
3495  
3500  
3505  
3510  
3515  
3520  
3525  
3530  
3535  
3540  
3545  
3550  
3555  
3560  
3565  
3570  
3575  
3580  
3585  
3590  
3595  
3600  
3605  
3610  
3615  
3620  
3625  
3630  
3635  
3640  
3645  
3650  
3655  
3660  
3665  
3670  
3675  
3680  
3685  
3690  
3695  
3700  
3705  
3710  
3715  
3720  
3725  
3730  
3735  
3740  
3745  
3750  
3755  
3760  
3765  
3770  
3775  
3780  
3785  
3790  
3795  
3800  
3805  
3810  
3815  
3820  
3825  
3830  
3835  
3840  
3845  
3850  
3855  
3860  
3865  
3870  
3875  
3880  
3885  
3890  
3895  
3900  
3905  
3910  
3915  
3920  
3925  
3930  
3935  
3940  
3945  
3950  
3955  
3960  
3965  
3970  
3975  
3980  
3985  
3990  
3995  
4000  
4005  
4010  
4015  
4020  
4025  
4030  
4035  
4040  
4045  
4050  
4055  
4060  
4065  
4070  
4075  
4080  
4085  
4090  
4095  
4100  
4105  
4110  
4115  
4120  
4125  
4130  
4135  
4140  
4145  
4150  
4155  
4160  
4165  
4170  
4175  
4180  
4185  
4190  
4195  
4200  
4205  
4210  
4215  
4220  
4225  
4230  
4235  
4240  
4245  
4250  
4255  
4260  
4265  
4270  
4275  
4280  
4285  
4290  
4295  
4300  
4305  
4310  
4315  
4320  
4325  
4330  
4335  
4340  
4345  
4350  
4355  
4360  
4365  
4370  
4375  
4380  
4385  
4390  
4395  
4400  
4405  
4410  
4415  
4420  
4425  
4430  
4435  
4440  
4445  
4450  
4455  
4460  
4465  
4470  
4475  
4480  
4485  
4490  
4495  
4500  
4505  
4510  
4515  
4520  
4525  
4530  
4535  
4540  
4545  
4550  
4555  
4560  
4565  
4570  
4575  
4580  
4585  
4590  
4595  
4600  
4605  
4610  
4615  
4620  
4625  
4630  
4635  
4640  
4645  
4650  
4655  
4660  
4665  
4670  
4675  
4680  
4685  
4690  
4695  
4700  
4705  
4710  
4715  
4720  
4725  
4730  
4735  
4740  
4745  
4750  
4755  
4760  
4765  
4770  
4775  
4780  
4785  
4790  
4795  
4800  
4805  
4810  
4815  
4820  
4825  
4830  
4835  
4840  
4845  
4850  
4855  
4860  
4865  
4870  
4875  
4880  
4885  
4890  
4895  
4900  
4905  
4910  
4915  
4920  
4925  
4930  
4935  
4940  
4945  
4950  
4955  
4960  
4965  
4970  
4975  
4980  
4985  
4990  
4995  
5000  
5005  
5010  
5015  
5020  
5025  
5030  
5035  
5040  
5045  
5050  
5055  
5060  
5065  
5070  
5075  
5080  
5085  
5090  
5095  
5100  
5105  
5110  
5115  
5120  
5125  
5130  
5135  
5140  
5145  
5150  
5155  
5160  
5165  
5170  
5175  
5180  
5185  
5190  
5195  
5200  
5205  
5210  
5215  
5220  
5225  
5230  
5235  
5240  
5245  
5250  
5255  
5260  
5265  
5270  
5275  
5280  
5285  
5290  
5295  
5300  
5305  
5310  
5315  
5320  
5325  
5330  
5335  
5340  
5345  
5350  
5355  
5360  
5365  
5370  
5375  
5380  
5385  
5390  
5395  
5400  
5405  
5410  
5415  
5420  
5425  
5430  
5435  
5440  
5445  
5450  
5455  
5460  
5465  
5470  
5475  
5480  
5485  
5490  
5495  
5500  
5505  
5510  
5515  
5520  
5525  
5530  
5535  
5540  
5545  
5550  
5555  
5560  
5565  
5570  
5575  
5580  
5585  
5590  
5595  
5600  
5605  
5610  
5615  
5620  
5625  
5630  
5635  
5640  
5645  
5650  
5655  
5660  
5665  
5670  
5675  
5680  
5685  
5690  
5695  
5700  
5705  
5710  
5715  
5720  
5725  
5730  
5735  
5740  
5745  
5750  
5755  
5760  
5765  
5770  
5775  
5780  
5785  
5790  
5795  
5800  
5805  
5810  
5815  
5820  
5825  
5830  
5835  
5840  
5845  
5850  
5855  
5860  
5865  
5870  
5875  
5880  
5885  
5890  
5895  
5900  
5905  
5910  
5915  
5920  
5925  
5930  
5935  
5940  
5945  
5950  
5955  
5960  
5965  
5970  
5975  
5980  
5985  
5990  
5995  
6000  
6005  
6010  
6015  
6020  
6025  
6030  
6035  
6040  
6045  
6050  
6055  
6060  
6065  
6070  
6075  
6080  
6085  
6090  
6095  
6100  
6105  
6110  
6115  
6120  
6125  
6130  
6135  
6140  
6145  
6150  
6155  
6160  
6165  
6170  
6175  
6180  
6185  
6190  
6195  
6200  
6205  
6210  
6215  
6220  
6225  
6230  
6235  
6240  
6245  
6250  
6255  
6260  
6265  
6270  
6275  
6280  
6285  
6290  
6295  
6300  
6305  
6310  
6315  
6320  
6325  
6330  
6335  
6340  
6345  
6350  
6355  
6360  
6365  
6370  
6375  
6380  
6385  
6390  
6395  
6400  
6405  
6410  
6415  
6420  
6425  
6430  
6435  
6440  
6445  
6450  
6455  
6460  
6465  
6470  
6475  
6480  
6485  
6490  
6495  
6500  
6505  
6510  
6515  
6520  
6525  
6530  
6535  
6540  
6545  
6550  
6555  
6560  
6565  
6570  
6575  
6580  
6585  
6590  
6595  
6600  
6605  
6610  
6615  
6620  
6625  
6630  
6635  
6640  
6645  
6650  
6655  
6660  
6665  
6670  
6675  
6680  
6685  
6690  
6695  
6700  
6705  
6710  
6715  
6720  
6725  
6730  
6735  
6740  
6745  
6750  
6755  
6760  
6765  
6770  
6775  
6780  
6785  
6790  
6795  
6800  
6805  
6810  
6815  
6820  
6825  
6830  
6835  
6840  
6845  
6850  
6855  
6860  
6865  
6870  
6875  
6880  
6885  
6890  
6895  
6900  
6905  
6910  
6915  
6920  
6925  
6930  
6935  
6940  
6945  
6950  
6955  
6960  
6965  
6970  
6975  
6980  
6985  
6990  
6995  
7000  
7005  
7010  
7015  
7020  
7025  
7030  
7035  
7040  
7045  
7050  
7055  
7060  
7065  
7070  
7075  
7080  
7085  
7090  
7095  
7100  
7105  
7110  
7115  
7120  
7125  
7130  
7135  
7140  
7145  
7150  
7155  
7160  
7165  
7170  
7175  
7180  
7185  
7190  
7195  
7200  
7205  
7210  
7215  
7220  
7225  
7230  
7235  
7240  
7245  
7250  
7255  
7260  
7265  
7270  
7275  
7280  
7285  
7290  
7295  
7300  
7305  
7310  
7315  
7320  
7325  
7330  
7335  
7340  
7345  
7350  
7355  
7360  
7365  
7370  
7375  
7380  
7385  
7390  
7395  
7400  
7405  
7410  
7415  
7420  
7425  
7430  
7435  
7440  
7445  
7450  
7455  
7460  
7465  
7470  
7475  
7480  
7485  
7490  
7495  
7500  
7505  
7510  
7515  
7520  
7525  
7530  
7535  
7540  
7545  
7550  
7555  
7560  
7565  
7570  
7575  
7580  
7585  
7590  
7595  
7600  
7605  
7610  
7615  
7620  
7625  
7630  
7635  
7640  
7645  
7650  
7655  
7660  
7665  
7670  
7675  
7680  
7685  
7690  
7695  
7700  
7705  
7710  
7715  
7720  
7725  
7730  
7735  
7740  
7745  
7750  
7755  
7760  
7765  
7770  
7775  
7780  
7785  
7790  
7795  
7800  
7805  
7810  
7815  
7820  
7825  
7830  
7835  
7840  
7845  
7850  
7855  
7860  
7865  
7870  
7875  
7880  
7885  
7890  
7895  
7900  
7905  
7910  
7915  
7920  
7925  
7930  
7935  
7940  
7945  
7950  
7955  
7960  
7965  
7970  
7975  
7980  
7985  
7990  
7995  
8000  
8005  
8010  
8015  
8020  
8025  
8030  
8035  
8040  
8045  
8050  
8055  
8060  
8065  
8070  
8075  
8080  
8085  
8090  
8095  
8100  
8105  
8110  
8115  
8120  
8125  
8130  
8135  
8140  
8145  
8150  
8155  
8160  
8165  
8170  
8175  
8180  
8185  
8190  
8195  
8200  
8205  
8210  
8215  
8220  
8225  
8230  
8235  
8240  
8245  
8250  
8255  
8260  
8265  
8270  
8275  
8280  
8285  
8290  
8295  
8300  
8305  
8310  
8315  
8320  
8325  
8330  
8335  
8340  
8345  
8350  
8355  
8360  
8365  
8370  
8375  
8380  
8385  
8390  
8395  
8400  
8405  
8410  
8415  
8420  
8425  
8430  
8435  
8440  
8445  
8450  
8455  
8460  
8465  
8470  
8475  
8480  
8485  
8490  
8495  
8500  
8505  
8510  
8515  
8520  
8525  
8530  
8535  
8540  
8545  
8550  
8555  
8560  
8565  
8570  
8575  
8580  
8585  
8590  
8595  
8600  
8605  
8610  
8615  
8620  
8625  
8630  
8635  
8640  
8645  
8650  
8655  
8660  
8665  
8670  
8675  
8680  
8685  
8690  
8695  
8700  
8705  
8710  
8715  
8720  
8725  
8730  
8735  
8740  
8745  
8750  
8755  
8760  
8765  
8770  
8775  
8780  
8785  
8790  
8795  
8800  
8805  
8810  
8815  
8820  
8825  
8830  
8835  
8840  
8845  
8850  
8855  
8860  
8865  
8870  
8875  
8880  
8885  
8890  
8895  
8900  
8905  
8910  
8915  
8920  
8925  
8930  
8935  
8940  
8945  
8950  
8955  
8960  
8965  
8970  
8975  
8980  
8985  
8990  
8995  
9000  
9005  
9010  
9015  
9020  
9025  
9030  
9035  
9040  
9045  
9050  
9055  
9060  
9065  
9070  
9075  
9080  
9085  
9090  
9095  
9100  
9105  
9110  
9115  
9120  
9125  
9130  
9135  
9140  
9145  
9150  
9155  
9160  
9165  
9170  
9175  
9180  
9185  
9190  
9195  
9200  
9205  
9210  
9215  
9220  
9225  
9230  
9235  
9240  
9245  
9250  
9255  
9260  
9265  
9270  
9275  
9280  
9285  
9290  
9295  
9300  
9305  
9310  
9315  
9320  
9325  
9330  
9335  
9340  
9345  
9350  
9355  
9360  
9365  
9370  
9375  
9380  
9385  
9390  
9395  
9400  
9405  
9410  
9415  
9420  
9425  
9430  
9435  
9440  
9445  
9450  
9455  
9460  
9465  
9470  
9475  
9480  
9485  
9490  
9495  
9500  
9

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise, as apparent from the following discussions, it is appreciated that

- 5 throughout the present invention, discussions utilizing the following terms refer to the actions and processes of a computer system or similar electronic computing device. These devices manipulate and transform data that is represented as physical (electronic) quantities within the computer system's registers and memories or other such information storage, transmission or 10 display devices. The aforementioned terms include, but are not limited to, "scanning" or "determining" or "generating" or "identifying" or "comparing" or "sorting" or "selecting" or "establishing" or "displaying" or "initiating" or the like.

#### EXEMPLARY PALMTOP PLATFORM

Figure 2 is a perspective illustration of the top face 100a of one embodiment of the portable computer system 100 of the present invention. The housing 102 is layered with an electronic muscle material that is a gel-like polymer that can convert electrical energy to mechanical energy and, 20 conversely, mechanical energy to electrical energy as it is expanded and contracted. By sensing the charge distribution across the material, one can determine the material's surface profile or contour. Vice-versa, by altering the charge distribution of the material, its surface profile can be altered. Alterations can be performed on localized portions of the material.

The top face 100a contains a display module 107 surrounded by a bezel or cover which is a portion of the housing and is layered with the electronic muscle material 102. The display module 107 comprises a display device 105 and touch sensors, 106 a, 106b and 106c which are able to register contact  
5 between the screen and the tip of a stylus or other similar input device. The stylus can be of any material to make contact with the touch sensors 106a, 106b, or 106c. In one embodiment icons 103 are silk-screened on the area of the bezel or cover, indicating locations where function buttons can be generated.

Figure 2 also illustrates a handwriting recognition pad or "digitizer" containing two touch sensor regions 106a and 106b. Region 106a is for the drawing of alphabetic characters therein (and not for numeric characters) for automatic recognition, and region 106b is for the drawing of numeric characters therein (and not for alphabetic characters) for automatic recognition. A stylus or similar input device, is used for stroking a character within one of the regions 106a and 106b. The stroked information is then fed to an internal processor for automatic character recognition. Once characters are recognized, they are typically displayed on the display device 105 for verification and/or modification.

Figure 3 illustrates the bottom side 100b of one embodiment of the palmtop computer system that can be used in accordance with various embodiments of the present invention. A battery storage compartment door 90 is shown. A serial port 180 and an infrared port 64 are also shown. In one

embodiment, infrared communication mechanism 64 is compliant with the IrDA (Infrared Data Association) standard and protocol.

Figure 4 is a block diagram of one embodiment of a portable computer

5 system 100 upon which embodiments of the present invention may be implemented. Portable computer system 100 is also often referred to as a PDA, a PJD, a palmtop, or a hand-held computer system.

Portable computer system 100 includes an address/data bus 300 for communicating information, a central (main) processor 410 coupled with the bus 300 for processing information and instructions, a volatile memory 420 (e.g., random access memory, RAM) coupled with the bus 300 for storing information and instructions for the main processor 410, and a non-volatile memory 430 (e.g., read only memory, ROM) coupled with the bus 300 for storing static information and instructions for the main processor 410. Portable computer system 100 also includes an optional data storage device 440 (e.g., a memory card) coupled with the bus 300 for storing information and instructions. Device 440 may be removable. Portable computer system 100 also contains a display device 105 coupled to the bus 300 for displaying information to the computer user.

In the present embodiment, portable computer system 100 includes a transceiver 480 providing it with the capability for wireless communication. The transceiver 480 provides a wireless radio frequency (RF) or infrared (IR) communication link between computer system 100 and other devices, using

any of the various RF or IR protocols and standards. In one embodiment, the Mobitex wireless communication specification is used. It is appreciated that transceiver 480 may be integrated into portable computer system 100, or that transceiver 480 may be a separate component coupled to portable computer  
5 system using, for example, serial port 180.

It is appreciated that, in another embodiment, portable computer system 100 may also include a telephony chipset or the like providing it with the functionality of a cellular phone, in particular the capability to transmit and receive cellular communications. In one embodiment, the telephony chipset is compatible with the standards for GSM and GPRS (Global System for Mobile Communications and General Packet Radio Service, respectively). It is appreciated that other telephony protocols and standards may also be used with the present invention.  
15

In the present embodiment, portable computer system 100 of Figure 3 includes communication circuitry 450 coupled to bus 300. In one embodiment, communication circuitry 450 is a universal asynchronous receiver-transmitter (UART) module that provides the receiving and transmitting circuits required for  
20 serial communication for both the serial port 180 and the infrared port 64. Communication circuitry 450 also includes digital signal processor (DSP) 460 for processing data to be transmitted or data that are received via transceiver 480.

Also included in computer system 100 is an optional alphanumeric input device 106 that, in one implementation, is a handwriting recognition pad ("digitizer"). Alphanumeric input device 106 can communicate information and command selections to main processor 410 via bus 300. In one implementation, 5 alphanumeric input device 106 is a touch sensor device. Alphanumeric input device 106 is capable of registering a position where a stylus element (not shown) makes contact.

P011250 "RECEIVED 6/6/00

Portable computer system 100 also includes an optional cursor control or directing device (on-screen cursor control 470) coupled to bus 300 for communicating user input information and command selections to main processor 410. In one implementation, on-screen cursor control device 470 is a touch sensor device incorporated with display device 105. On-screen cursor control device 470 is capable of registering a position on display device 105 where a stylus element makes contact. The display device 105 utilized with portable computer system 100 may be a liquid crystal display (LCD) device, or other flat panel display device suitable for generating graphic images and alphanumeric characters recognizable to the user. In the preferred embodiment, display device 105 is a flat panel display.

20

The portable computer system 100 also includes a battery 40 coupled to bus 300 for powering the system when the computer is being used in the portable mode.

The electronic muscle material 490 that is comprised in the housing of the device is coupled such that it can be controlled by signals that are on bus 300 for interfacing with processor 410, communication circuitry 450, DSP 460, and/or battery 40. In the present embodiment this electronic muscle material 5 490 is the dielectric elastomer material described herein. When this electronic muscle material 490 is stretched and then allowed to contract, the elastic stresses work against electric field pressure and increase electrical energy. Thus, in one embodiment, as pressure is applied to the housing comprising this material, an electric charge is created which can then charge the battery 40, 10 eliminating the need for external charging devices. As the PDA is handled daily, the battery can thus be recharged.

PAPERS - DRAFT

Figure 5 is a block diagram illustrating the process 500 of generating customized features by the electronic muscle material in one embodiment of the invention. Block 510 indicates the sensing, by the electronic muscle material comprised in the device, of the device being picked up by a user up and handled along the sides. Block 520 includes the determination by the processor, based on the profile of the electrical charge distribution on the electronic muscle material, of the location of hand and/or finger placement on 20 the housing of the device and, thus the handedness of the user. Figure 6 further illustrates how the pressing 610 of the electronic muscle redistributes the charges 620. The strength of the charge and its distribution can then be interpreted to determine the hand and/or finger placement.

Block 530 of Figure 5 represents the performance of some customization feature, based on the known handedness of the user, with respect to the user interface of the electronic device. In one embodiment of the present invention this customization feature is the generation of function buttons in closest proximity to the user's fingers, once the hand and finger placements are sensed. These buttons could be scroll buttons 710 or menu selection buttons 720, as illustrated by Figure 7.

10  
15  
20  
25  
30  
35  
40  
45  
50  
55  
60  
65  
70  
75  
80  
85  
90  
95  
100

Referring now to Figure 8a, in one embodiment the top surface of the housing 810 is comprised of a layer of rigid or semi-rigid material (e.g., plastic) covering the electronic muscle material 80. In this embodiment there would be openings in the top surface 820 at designated locations along the sides of the housing. Depending on the handedness of the user, the electronic muscle material 80 would grow buttons 830 through the openings in the housing along the side corresponding to the determined handedness of the user.

In the embodiment of the present invention illustrated by Figure 8b, the top surface of the housing 840 is comprised of a layer of rigid or semi-rigid material covering the electronic muscle material. Icons 850 representing the functions of the user interface are silk-screened on the top layer of the housing 840. When the icon 850 is pressed by the user, the electronic muscle material 80 beneath the top layer becomes the button 860 to send a signal to the processor to perform the designated function.

Figure 8c illustrates one embodiment of the present invention in which the electronic muscle 80 forms the outer layer of the housing. The function buttons are created by the electronic muscle material in any of a plurality of variable positions 870. The positions for the buttons would be in the proximity of 5 the user's fingers, depending on the determined handedness and finger position of the user.

This determination of handedness and finger placement followed by the generation of buttons in the proximity of the fingers improves the user interface. 10 In the prior art, a left-handed person with large fingers needing to operate the device with a single hand could find it difficult to manipulate the buttons, and their hand could obscure portions of the screen. The present invention would facilitate single-handed use of the portable computer or device.

15 Figure 9 is a block diagram 900 illustrating alarming and messaging using the electronic muscle material of the present invention. In one embodiment, the processor receives an alarm message from a source such as an appointment calendar, low battery sensor, etc. as shown in block 910. The processor then issues a signal to the electronic muscle and to the display 20 device. The display device displays, as shown in block 930, a relevant message to inform the user of the source of the alarm.

25 Still referring to Figure 9, the electronic muscle senses 920 if the user is holding 940 the device. If not, the entire electronic muscle vibrates 980, thereby vibrating the portable computer for apprising the user that an alarm message is

being displayed. If the device is being held 940, the alarm configuration is checked 950 to determine the alarm configuration setting. If the configuration is set to vibrate 960 a button, then the electronic muscle will vibrate at the appropriate button location. If the configuration is set to protrude 970 a button,

5 the electronic muscle will expand at the location of the appropriate button to cause it to protrude. If the device is configured to alarm by vibrating the entire device, then that mode is employed 980.

In another embodiment, the alarm configuration could require an audible alarm in which case the electronic muscle material can function as a speaker to issue said alarm. This function is covered in more detail below with reference to Figure 12.

Referring now to Figure 10, one embodiment of the present invention is illustrated in which the exterior or peripheral placed electronic muscle material comprised in the housing conforms to the shape of the user's hand. The electronic muscle material has a high elastic modulus and is capable of easily molding to the hand's contour. This characteristic functions to create a more comfortable device for the user. The user can alternately squeeze and release the housing of the device containing the gel-like electronic muscle material, thus exercising the user's hand and wrist while simultaneously charging the battery 40 in the device per Figure 4.

Referring now to Figure 11, when a user picks up and handles the electronic device 111, the electronic muscle material changes shape to conform

to the users hand. Based on the profile of the charge distribution in the electronic muscle material, e.g., along the left and right sides, the surface contour is checked 112 against a pre-stored contour map of the conformance to the authorized user's hand to identify the user and to authorize 113 his/her

- 5 access to the device, in one embodiment of the present invention.

Figure 12 illustrates the use of the device housing 120, comprising the electronic muscle material, as a speaker. The characteristics of this material include good impedance matching to many energy sources. Thus, the  
10 electronic muscle material can be caused to vibrate 121 at prescribed frequencies, modulating the surrounding air and producing sound 122. This eliminates the need to include within the present invention separate speaker devices for producing sound. Additionally, the speaker can be localized at any position along the electronic muscle material and can therefore be spatially  
15 adjusted to an optimum position for the best user experience.

Likewise, as shown in Figure 13, the electronic muscle can vibrate in response to signals from external sources. The electronic muscle of the device can sense the direction from which the sound emanates. The vibration can  
20 move dynamically around the housing 130 to receive the greatest signal strength. This allows for the provision of a variable position microphone. At a meeting in a conference room, for example, the sound from an attendee speaking from location 131 would set up a vibration in the electronic muscle of the housing of device 130 at location 132. Likewise, the sound from someone  
25 speaking at location 133 would set up a vibration at location 134. These signals

can then be stored and later regenerated by the speaker function discussed with Figure 12.

In summary, embodiments of the present invention provide the user of

- 5 portable computer devices with interfaces for performing a plurality of tasks. The housing of the device in the present invention comprises a dielectric elastomer material known as an electronic muscle material. This housing provides an automatic battery-charging interface. It provides the capability of adapting the scroll and menu function button locations to ones most convenient to the user. It  
10 provides said buttons as an integral part of the housing, eliminating the potential failures that can occur in mechanical buttons of the prior art. The housing can vibrate in part or entirety to apprise the user of an alarm message. The housing can also conform to the contour of the user's hand for improved ergonomics and can use this conformation for identification and authorization of  
15 the user. Further, the electronic muscle material of the housing of the device can vibrate to modulate the air so as to function as a speaker and a microphone integral with the device.

The present invention has been described in the context of a portable

- 20 computer system; however, the present invention may also be implemented in other types of devices having, for example, a housing and a processor, such that the device performs certain functions on behalf of the processor. Furthermore, it is appreciated that these certain functions may include functions other than those associated with navigating, vibrating, sensing and generating  
25 audio output.

The preferred embodiment of the present invention, implementation of electronic muscles in a portable computer for navigation, vibration, audio output and as a general sensor, is thus described. While the present invention has  
5 been described in particular embodiments, it should be appreciated that the present invention should not be construed as limited by such embodiments, but rather construed according to the below claims.

PCT/US2003/036060